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HENRY SHREVE REMOVES THE GREAT RAFT

A steamboat route around the Great Raft on the Red River was available by 1831. This route was east of the river out of Natchitoches and west of the river out of the area of present-day Shreveport. The portion of the route out of the area of present-day Shreveport was developed by Lt. Washington Seawell from 1829 to 1831 and included Twelvemile Bayou, Soda and Clear lakes (now extinct), Black Bayou, Seawell's Canal, and Red Bayou, which connected with the Red River above the head of the raft. This route was used by the *Enterprise* to reach the upper Red River in June 1831.

Although this route was usable, it was also dangerous, time consuming, and expensive because of high insurance rates. The people of Arkansas wanted the raft to be removed because a raft-free Red River would provide more efficient transport. They also wanted to reclaim lands that had been flooded by the raft and to prohibit the flooding of new lands as the raft moved upstream. Their appeals to Congress for raft removal were joined by New Orleans, which was the primary beneficiary of the Red River trade.

Congress directed the Corps of Engineers to remove the raft, and the assignment was given to Capt. Henry Miller Shreve, who had been appointed Superintendent of Western River Improvements in 1826. Shreve accepted the assignment without ever having seen the raft and in spite of widespread skepticism that the raft could be removed. Shreve was confident because he had developed the current snagboat technology that had been applied in snag removal on the Ohio and Mississippi rivers. The Red River raft was merely a technical problem of larger magnitude.

When Shreve began to remove the raft in 1833, the foot was east of present-day Forbing, Louisiana (about eight straightline miles below downtown Shreveport), and its head was in the vicinity of Cowhide Bayou (about 16 straightline miles above downtown Shreveport). Shreveport, of course, was not in existence at this time. The Red River was a wilderness area above Natchitoches that could not be settled because of the existence of the raft.

Shreve arrived at the downstream debris deposits in April 1833 with 159 men, the snagboat *Archimedes*, and the steamboats *Java*, *Souvenir*, and *Pearl* and immediately began to work. The general plan of action was to use the *Archimedes* to pull and dismember logs, with stumps disposed off channel and floatable logs left instream to be carried out by the next rise in the river. Debris was used to block the mouths of distributaries so that flows would be concentrated in the main channel. Overland cuts were to be made at key points to reduce the navigation distance.

Shreve operated on the basis of annual appropriations, which were exhausted by June. He produced a survey map of the raft area and had reached the halfway point by the end of the first season of operation. The ease with which the downstream decayed materials were removed led him to underestimate the dimensions and costs of the task at hand. The task was to extend over six years, but with only 22 months of concerted effort.

Shreve arrived back at the raft in December 1834 with additional workboats and personnel. By March 1835, he had cut off a narrow neck of land, producing the area in Shreveport designated as Shreve's Island. When the work ended in May, he had advanced as far as Twelvemile Bayou above present-day Shreveport.

Shreve was back at work on the raft in January 1836. This was the first time that he was able to observe the compact upstream portions of the raft and the continuous accumulation of materials at

Shreve's Survey Map

the raft's head, both of which caused him to be more cautious in his expectations. By May, when the work closed, he had advanced to one mile above Willow Chute.

In 1837, Shreve nearly reached his goal, arriving within 440 yards of the head of the raft at the close of work in May, which was facilitated by a new snagboat, the *Eradicator*. Raft removal was completed in March 1838, when one of the workboats forced its way through the remaining section of raft, and five commercial vessels passed through the area on the way upriver.

Success was to be short-lived. Each time the raft segment was removed a new one soon formed; and in October 1840, navigation was permanently closed pending additional Congressional appropriations. In 1841, with a change of administrations in Washington, Shreve was relieved of this position as Superintendent of Western River Improvements.

Although Shreve temporarily removed the raft, he did not succeed in his objective to open the Red River for navigation. However, his efforts were highly beneficial. The raft was permanently removed from the river to above present-day Shreveport, and this area was open to navigation and settlement. Shreveport came into existence as a major Red River port. The eastern raft bypass out of Natchitoches was eliminated, and steamboats were able to enter the western bypass out of Shreveport to the upper Red River immediately from the river.

LOCK AND DAM DESIGN INNOVATIONS

Potential innovations in the design of the locks and dams that would be built above Shreveport-Bossier City are identified in a recently completed study. The purpose of the study was to determine whether alternatives to standard lock and dam designs were feasible and whether they could produce significant reductions in the anticipated costs of the navigation project. Reduction in project costs would improve economic feasibility.

The study addressed lock and dam features such as lock gates, stilling basins for the water that passes over the dams, lock walls, lock guidewalls for properly aligning towboats and barges entering and exiting the lock, lock filling and emptying systems, and the potential for allowing flows through lock chambers during extreme high flows on the river.

An analysis was conducted of the costs of the locks and dams below Shreveport-Bossier City to determine which features offered the greatest potentials for cost savings. The analysis indicated that the lock used for moving towboats and barges between navigation pools was more expensive than the dam which created the navigation pool. Excavation costs and concrete and structural steel costs were found to offer the greatest potentials for cost savings in dam construction. Excavation, guidewall, and concrete and structural steel costs were found to offer the greatest potentials for savings in lock construction.

A wide range of alternatives was considered, some of which were rejected. One rejected alternative was building the dams in the river and the locks in separate excavated channels. This alternative offered significant savings in lock design; however, these savings were found to be more than offset by increased excavation costs. Using the lock chambers for high-water flow-through to potentially reduce the number of gates needed on the dams was also investigated. This alternative was also rejected because the number of gates needed on the dams was found to not be significantly reduced, and sediment deposited in the lock chamber would interfere with lock operations. Offsite construction of various components with waterborne transport to the site was determined to be impractical because the Red River above Shreveport-Bossier City is often too low.

Many dam features are fixed, and little can be done to reduce the number of gates without producing unacceptable impacts. However, opportunities do exist for cost reductions through the use of alternatives to solid concrete for the foundations of the dams and stilling basins, such as pile foundations.

Locks are usually built for high volumes of traffic that require brief emptying and filling times for the lock chamber. Since lower traffic volumes are expected above Shreveport-Bossier City, longer emptying and filling times are feasible. This would enable the use of smaller culverts to fill the locks under traditional lock design or the use of a flume system in which water would enter the lock chamber through numerous portals.

Concrete is the largest cost component in locks. Standard lock walls are built of concrete. However, lock walls can be built using cellular sheet piles filled with gravel, or using sloped earthen materials, or using a combination of these approaches. Sloped earthen walls would have the disadvantage of requiring more water to fill the lock chamber.

Standard guidewalls, which are located at the upstream and downstream ends of the lock chamber, are normally built of concrete. However, the upstream guidewalls could be built using cellular sheet piles or floating guidewalls with stone revetments; and the downstream guidewalls could be built using cellular sheet piles with reinforced concrete beams.

The recommended design is to construct the dams on pile foundations adjacent to the locks. A flume system would be used to fill and empty the lock. The landside wall of the locks would be sloped earth. The upstream guidewalls would be floating with stone revetments, and the downstream guidewalls would be piles and stone revetments.

This design would provide considerable savings while maintaining safe and reliable navigation for barge and recreational traffic. The design is preliminary and will be further developed and modified as the engineering and geotechnical studies progress.

DETERMINING TRANSPORTATION BENEFITS

The benefit/cost (B/C) ratio is the key element in determining the feasibility of a project. The B/C ratio is a ratio of annual project benefits to annual project costs. To be economically justifiable, annual project benefits must be equal to or exceed annual project costs. Thus, the B/C ratio must be 1:1 or better. In money terms, this means that every dollar spent on a project must secure national benefits of at least one dollar.

Most public interest in navigation projects stems from expectations about new firms that will come to an area to make use of a waterway. However, induced development may not provide national benefits. The reason is that simply moving from one area of the country to another area may not provide any cost savings; therefore, tonnage from such firms could not be counted in the economic evaluation of a federal project. If the determination is made that relocating to a site on the Red River would allow a firm to produce goods at a lower overall cost, then there would be national benefits and these could be counted toward project feasibility.

The major national benefit secured through a navigation project is increased economic efficiency obtained by transportation cost savings for existing firms already in a geographic area that will be affected by a project.

Barge transportation is slow in comparison to other transportation modes such as rail and truck. Thus, barges generally carry time-insensitive high-volume products and raw materials. However, barges have certain advantages over other transport modes. Four barges have the same carrying capacity (6,000 tons) as 60 jumbo rail cars and 150 large semi-trailer trucks. In addition, barges are fuel-efficient. A barge can move one ton 500 miles on a gallon of fuel, compared to 200 miles for a rail car and 50 for a truck.

Determination of transportation cost savings is a two-step process. First, the potential users of a waterway must be contacted to see if they have any incoming or outgoing commodities that could make use of barge transportation. The Arkansas Red River Commission is conducting most of the potential user surveys. The objective of this effort is to contact every firm that has a potential to transport commodities on the waterway; to determine existing production, transport modes, and markets; and to identify existing and potential tonnages that might move to the waterway. All data collected from potential waterway users is kept confidential to avoid disclosure of sensitive firm operations.

The second step in the process is to determine whether a shift to barge transportation would provide any transportation cost savings to the firms indicating potential movements and, if so, by what amount. A firm will not shift to a waterway unless it can achieve reductions in its total transport costs from point of production to point of sale. Although water transport is less expensive on a ton-per-mile basis, total costs typically include transport to the waterway by truck or rail, onloading to barges, transport on the waterway, offloading, and transport by truck or rail to point of sale.

Information on potential tonnages obtained from firms in the region is sent to Lee Robinson, an economist with the Vicksburg District, who may recontact the firms to clarify information on the survey forms. The District then conducts a preliminary transportation cost savings analysis for each firm by using a model developed by the transportation management consultants, Reebie Associates. Some of the information obtained from the field is also sent to Chris Dager, a transportation rate specialist with the Tennessee Valley Authority, who conducts a similar analysis using a modified Reebie model. This provides a cross-check on the District analysis and provides a more refined analysis of transport cost savings.

Loaded Barges

WATER AND SEDIMENT QUALITY ANALYSIS

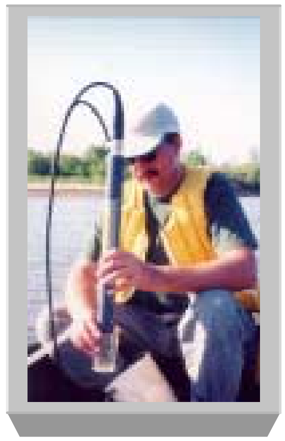
Characterization of the quality of water and sediments requires summer low-water investigations and winter high-water investigations. A summer low-water investigation of the quality of the water and sediments of the Red River above Shreveport-Bossier City was completed last year; the winter high-water investigation will be completed this year. These investigations will determine the pre-project baseline conditions. After the second investigation is conducted, post-project conditions will be projected on the basis of the observed changes that have taken place in the completed project below Shreveport-Bossier City.

The summer low-water investigation was conducted by a three-person team in a boat. Samples from the water column were taken with a submersible pump. Samples from the sediments beneath the water were taken with a petit ponar dredge, which has two jaws that close around the sediment. A Hydrolab was used to conduct on-site analysis of the water samples for some parameters such as temperature and dissolved oxygen that degrade quickly. However, most of the analytical work was done by a Baton Rouge laboratory.

Sediment and water samples were taken along the entire 134-mile reach of the Red River between Shreveport-Bossier City and Index, Arkansas. Samples were taken in oxbow lakes as well as in the river channel because some oxbows will be affected by project-induced water elevation rises. One water sample was taken at mid-depth at each of seven river channel sites; and two were taken at each of three oxbow sites, one at near-surface and the other at near-bottom. One sediment sample was taken at each of seven river channel sites and three oxbow sites.

River water samples were analyzed for priority pollutant metals such as arsenic and lead and nutrients such as phosphorous and potassium. Oxbow water samples were analyzed for nutrients, and the samples taken from near the bottom were also analyzed for priority pollutant metals. All sediment samples were analyzed for nutrients, priority pollutant metals, and pesticides.

Analysis of the water samples for priority pollutant metals indicated that one of the oxbow samples exceeded water quality standards for nickel, and two of the river samples exceeded the standards for zinc, but only slightly. Turbidity standards were exceeded by two oxbow samples, and one river sample slightly exceeded the standards for pH (a measure of acidity, and alkalinity). Analysis of the sediment samples for priority pollutant metals and nutrients indicated concentrations at or below typical concentrations for natural soils. Pesticide concentrations, if present, were below the laboratory's minimum detection limits.



The water sample results are consistent with Red River water quality monitoring efforts conducted by Arkansas and Louisiana and, in general, meet state and federal water quality standards. Sediment sample results are consistent with typical concentrations in natural soils. Overall, the results, in general, meet the applicable state and federal standards, and none of the six detected exceedences indicate any potential threat to the environment.

If you would like more information on the study, please contact:

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You are invited to visit the Southwest Arkansas Navigation Study webpage at:
http://www.mvk.usace.army.mil/offices/pa/sans/main.htm

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